X ray Reflectivity Study of Gold Colloid Monolayers	X22B

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The structure of Langmuir films of gold colloids, consisting of 2nm diameter gold particles coated with C_{14} thiol chains, was studied by X ray reflectometry and grazing incidence diffraction, over a range of compression and surface pressure. Figure 1 shows the isotherm, and figure 2 shows the specular reflectivities measured at the points marked. At large values of the area per particle (i.e. low surface pressure) the reflectivity indicates a single layer, approximately 1.5nm thick, corresponding to a monolayer of the gold colloid. The roughness of this layer is about 1nm, which probably arises from polydispersity in the size of the gold colloid, and incomplete monolayer coverage at large areas (islands of the colloid film can be seen on the water surface until a certain compression is reached). At an area of approximately $6.5nm^2$ per particle, a transition occurs. This is seen as a steep rise in the isotherm. Fringes appear in the reflectivity, indicating a change in thickness. The data can be interpreted by a model, consisting of water, a 2.5nm gold layer, a 1.5nm hydrocarbon layer, and a second 2.5nm gold layer. Thus a monolayer to bilayer transition has taken place. In the bilayer, the centre to centre spacing of the gold layers is 4nm. As the layer is compressed further, the amplitude of the fringes increases, indicating that more of the film is being converted from monolayer to bilayer.

The in-plane structure of the layers was studied with grazing incidence diffraction, at the same points on the isotherm as the specular reflectivity. In each case, a diffraction peak was observed at an angle of 2.9°. This corresponds to an in plane spacing of 3.8nm, between the centres of the gold particles (in good agreement with the 4nm from specular reflectivity of the bilayer). No higher order peaks are observed, and the peak is fairly broad. This indicates that while there is a constant nearest neighbour spacing in the layer, there is no long range order. The intensity of the peak drops sharply at the point where the monolayer-bilayer transition occurs, and the peak width correspondingly increases. This suggests that there is no correlation in the position of the particles between the two layers.

Further experiments have also investigated the effects of temperature and alkyl chain length in this system.

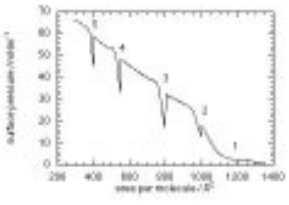

Figure 1. Surface pressure - area isotherm for the gold colloid. The points indicate the ions where the reflectivity was measured. Features in the isotherm, can be indentified with changes in the structure of the layer with the aid of techniques such as reflectivity.

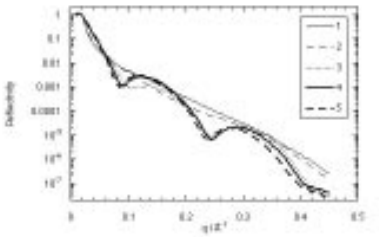

Figure 2. The specular reflectivites corresponding to the points marked on the isotherm in figure 1. The fringes arise when the film goes from a monolayer to a bilayer.